Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM32-P01 Room:503 Time:May 2 16:15-17:30

Magnetothermal instability in the solar outer corona

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We discussed an application of the magnetothermal instability (MTI) to the solar atmosphere. This instability proposed by Balbus (2000) occurs in weakly collisionless plasmas where non-isotropic thermal conduction plays a role in a magnetized atmosphere. The time scale of the maximum growth is given as approximately sqrt(H/g) where H is the scale height, and g is the gravity. The magnetic field must be weak enough since its tension force contributes as a restoring force.

The solar corona is a dilute hot atmosphere where the thermal conduction is non-isotropic. The MTI is possible to work in the upper corona around a few solar radii above the photosphere where the temperature is decreasing outward and the scale height is about one solar radius. The condition for weak horizontal magnetic field might be satisfied above a closed loop in the lower corona. If the MTI is effective in such regions, it might contribute to generate the waves or perturbations in the solar wind.

We found that the MTI is unlikely to work in the upper corona because of its strong magnetic field that suppress the growth of the geometrically possible wavelength modes. It is found that when the field strength is 0.1 times the real corona, the wavelength for the maximum growth is comparable with the geometrical radius. The growth time for this setup can be consistent with the low frequency fluctuations in the solar wind.

Keywords: Sun, corona, plasma, magnetohydrodynamics

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Cosmic-ray Parker Instability and Galactic Plane Symmetry

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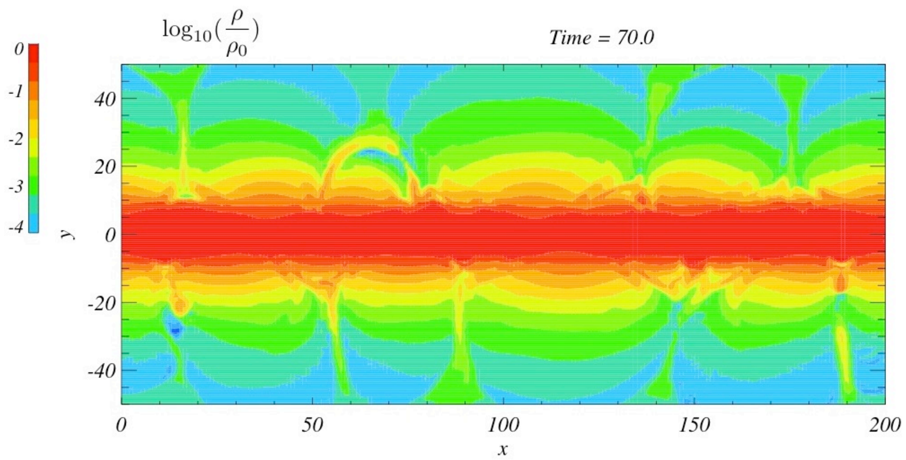
We study two-dimensional MHD numerical simulations of the Parker instability with the cosmic-ray pressure under the circumstance of the galactic disk. Instead of the symmetric boundary conditions on the galactic plane as often used, we solve the entire region of the disk. Numerical simulations show that the symmetric mode on the disk also grows when the cosmic-ray pressure is relatively large, while the glide reflection symmetric mode dominates on the disk when the cosmic-ray pressure is small. We confirm that the results are consistent with those of the liner analyses: the growth rate of the symmetric mode approaches that of the glide reflection symmetric mode as the cosmic-ray pressure becomes relatively large.

In the nonlinear stage, some loop structures of the magnetic field lines expand rapidly and grow into large structure when the cosmic-ray pressure is relatively large. Other loops, which start to grow a little later, are suppressed by faster growing loops located nearby and do not reach the nonlinear expansions. Eventually, the loop structure at the nonlinear stage is larger than that is expected form the linear analysis when the cosmic-ray pressure is relatively large.

When the nonlinear fast growing loops collide with another loops, the high density thin gas layers are formed by the compression between the loops. The figure shows the logarithmic density at that stage. Some of the high density gas shows filament structures and some of them look like high density loops. Similarities of these structures with some observational features and the relation of star formation activities can be studied further.

Keywords: MHD, Interstellar gas, Cosmic rays



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Formation of Dense, Cold Loops by Parker Instability in Galactic Gas Disks

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We performaced two dimensional numerical simulations of Parker instability taking into account the cooling and heating functions of the interstellar medium (Inoue et al. 2006). Our numerical experiment is based on the simulation code "CANS+" in which the HLLD Riemann solver (Miyoshi & Kusano 2005) is used to solve the MHD equations. We found that the cold, dense filaments formed at the valley of magnetic field lines by Parker instability coupled with the cooling instability are deformed into loops of dense, cold gas when the Ram pressure at the left- and right-hand side of the filament is different. The maximum number density and the lowest temperature of cold, dense filament at 100Myrs is about 200 per cubic cm and 50K, respectively. These results support the model in which thermal instability triggered in the dense region formed by Parker instability is responsible for the formation of molecular loops found in the Galactic center region (e.g., Fukui et al. 2006).